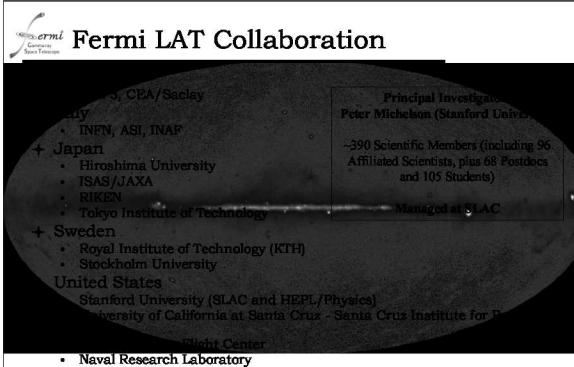


**Fermi-LAT Observations of Galactic Transients**

*Elizabeth Hays  
(NASA/GSFC)  
on behalf of the Fermi-LAT  
Collaboration*



### Fermi LAT Collaboration

Principal Investigator  
Peter Michelson (Stanford University)

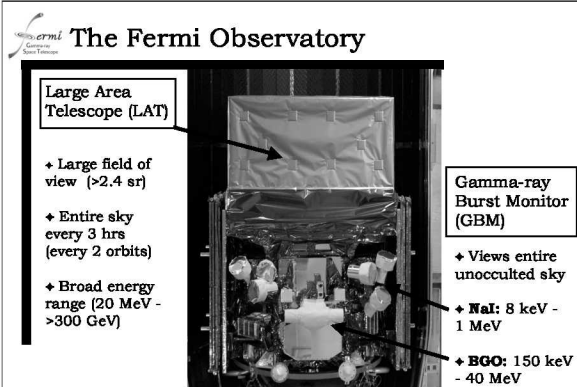
~390 Scientific Members (including 96 Affiliated Scientists, plus 68 Postdocs and 105 Students)

Managed at SLAC

- Italy
  - INFM, ASI, INFN
- + Japan
  - Hiroshima University
  - ISAS/JAXA
  - RIKEN
  - Tokyo Institute of Technology
- + Sweden
  - Royal Institute of Technology (KTH)
  - Stockholm University
- United States
  - Stanford University (SLAC and HEPL/Physics)
  - University of California at Santa Cruz - Santa Cruz Institute for Particle Physics
  - University of Wisconsin - Madison
  - University of Washington
  - Naval Research Laboratory
  - Sonoma State University
  - Ohio State University
  - University of Washington

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### The Fermi Observatory

**Large Area Telescope (LAT)**

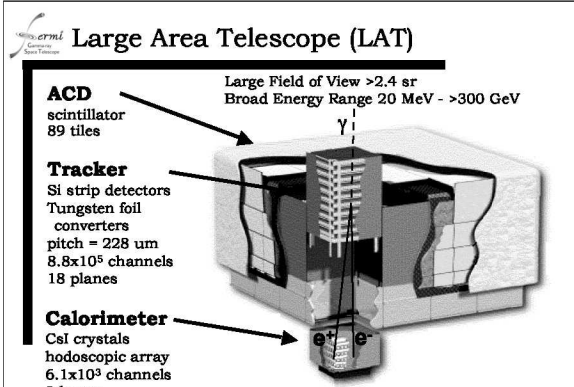
- + Large field of view ( $>2.4$  sr)
- + Entire sky every 3 hrs (every 2 orbits)
- + Broad energy range (20 MeV -  $>300$  GeV)

**Gamma-ray Burst Monitor (GBM)**

- + Views entire unocculted sky
- + NaI: 8 keV - 1 MeV
- + BGO: 150 keV - 40 MeV

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### Large Area Telescope (LAT)

**ACD**  
scintillator  
89 tiles

**Tracker**  
Si strip detectors  
Tungsten foil converters  
pitch = 228  $\mu$ m  
 $8.8 \times 10^5$  channels  
18 planes

**Calorimeter**  
CsI crystals  
hodoscopic array  
 $6.1 \times 10^3$  channels  
8 layers

Large Field of View  $>2.4$  sr  
Broad Energy Range 20 MeV -  $>300$  GeV

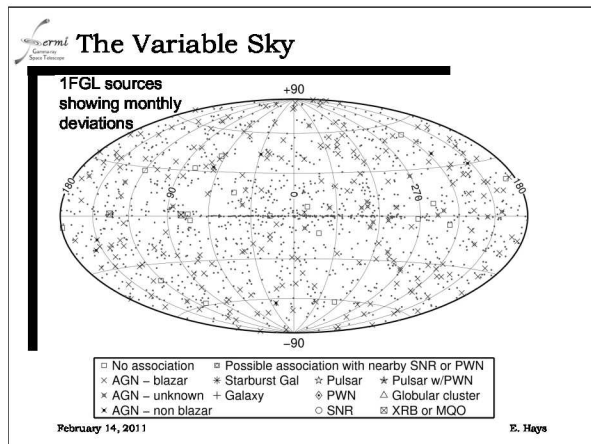
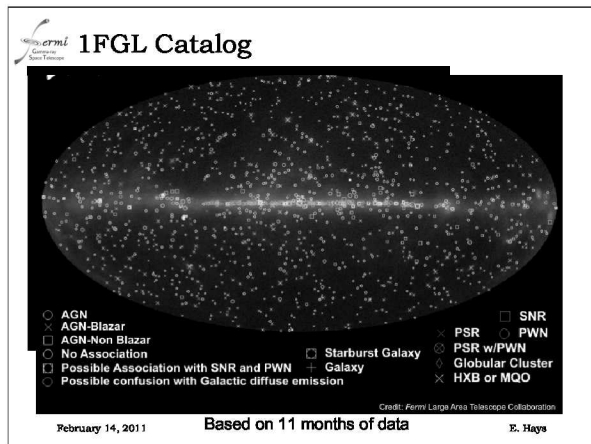
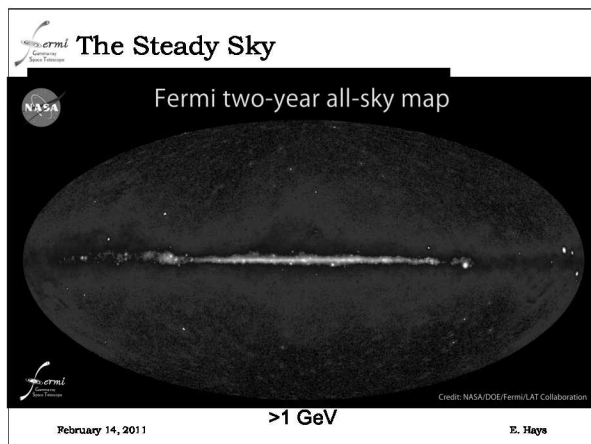
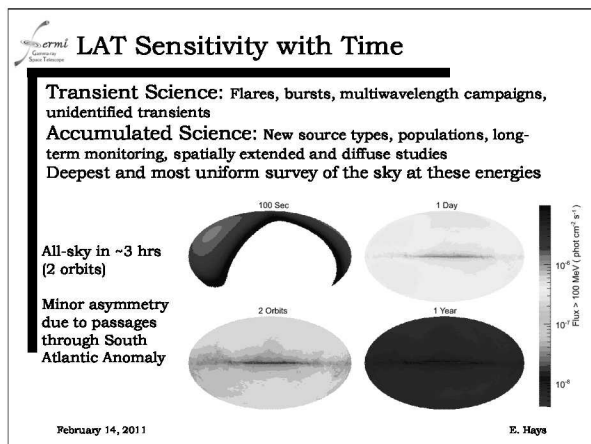
$\gamma$


$e^+ e^-$

4x4 detector array

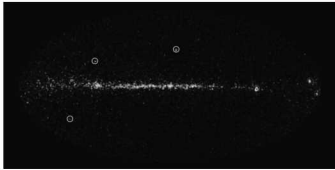
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 **LAT Automated Science Processing**

All-sky search runs every 6 hours, 1 day, 1 week




LAT counts map  
E > 100 MeV, 6 hours

LAT flare advocates monitor data daily and trigger multiwavelength follow-up. Also check for interesting transients reported in other wavebands.


- > 100 Astronomer's Telegrams
- Public lightcurves through FSSC at <http://fermi.gsfc.nasa.gov/ssc>
- Weekly and Special Reports <http://fermisky.blogspot.com>

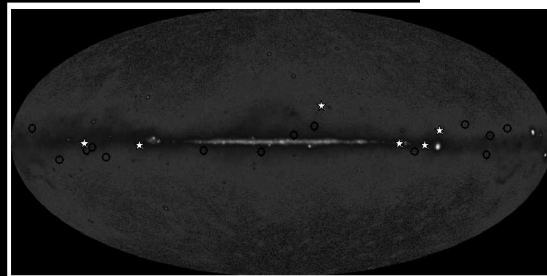
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 **Flaring Galactic Sources in the LAT**

- + Search for new transients near the Galactic plane
- + Cygnus X-3
- + Nova of V407 Cygni
- + Crab Nebula


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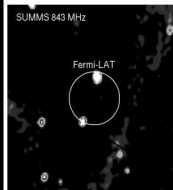
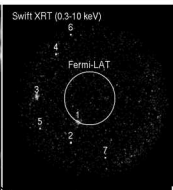
 **LAT Unassociated Transient Detections**



- ☆ Unassociated transients from daily search
- Low latitude blazars from First LAT Catalog

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 **Counterpart Search - Fermi J0910-5041**

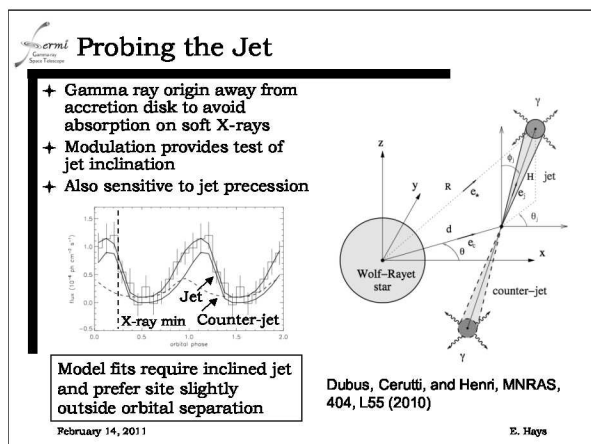
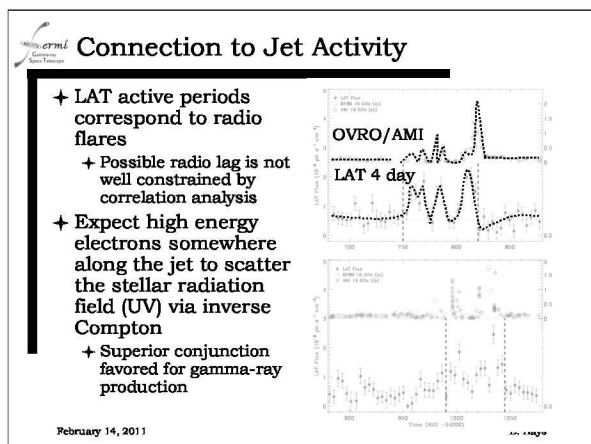
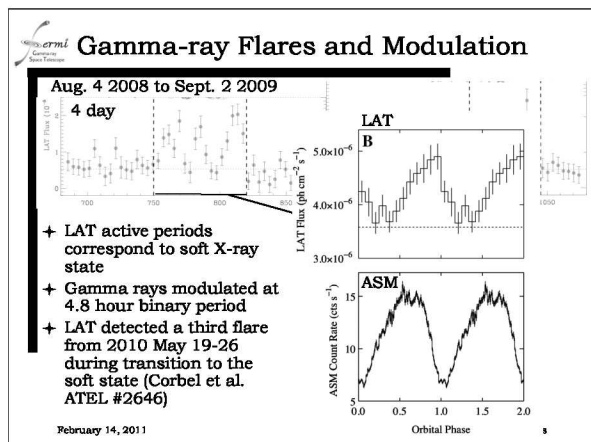
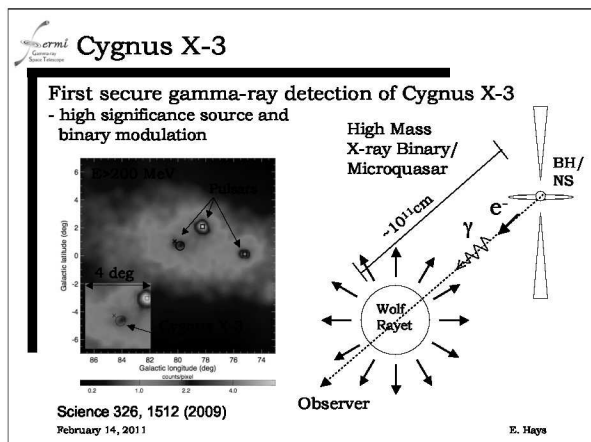



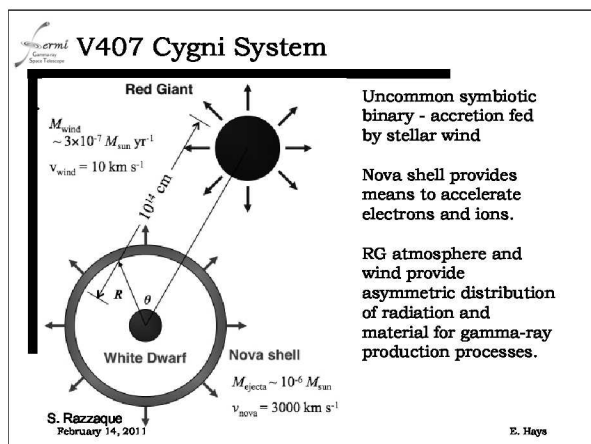
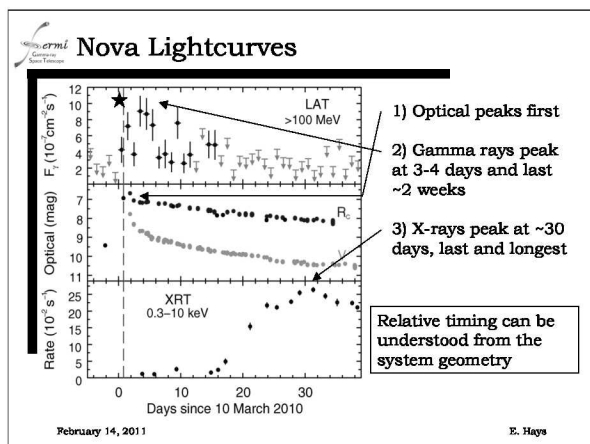
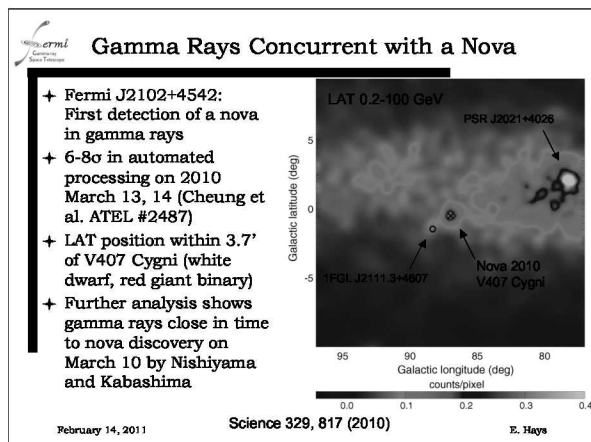
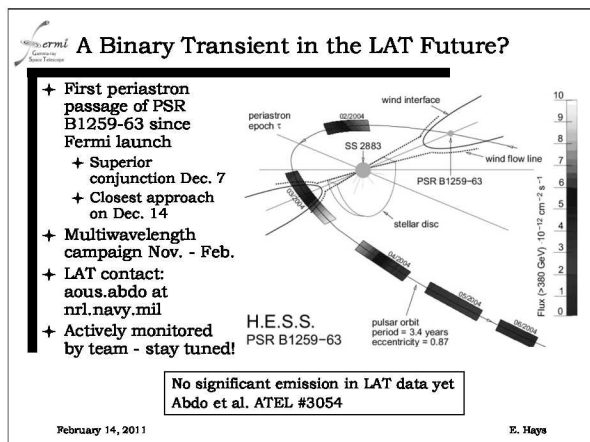
**Fermi J0910-5041**  
(ATEL #1788)

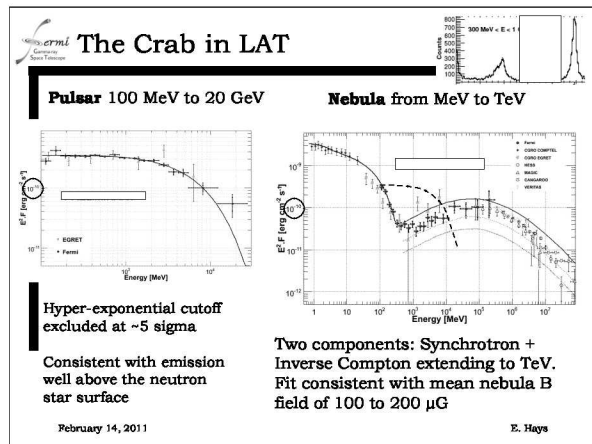
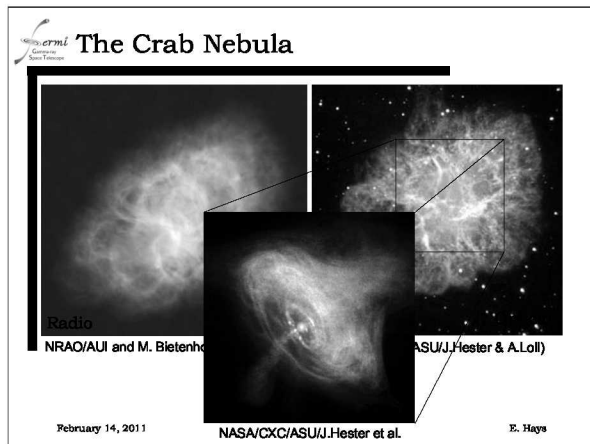
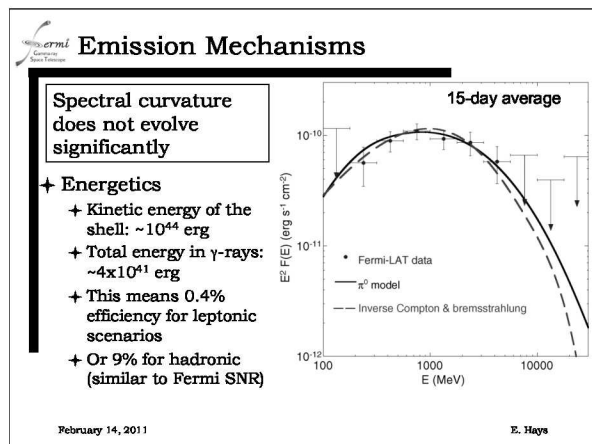
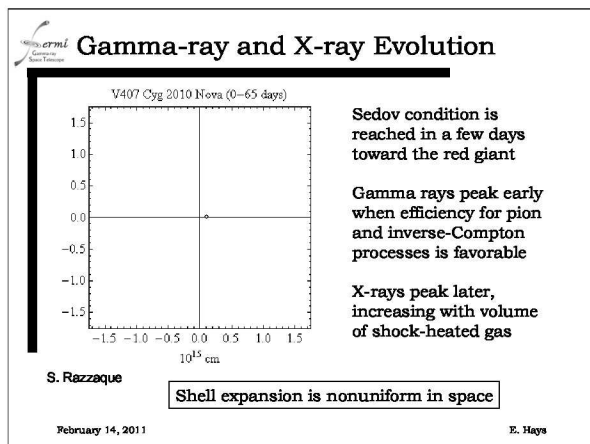
- October 15, 2008
- ~10x above average gamma-ray flux for 2 days
- Swift XRT ToO within 1 day
- 1 of 2 high confidence LAT transients without a firm counterpart

LAT 95% error circle contains Swift XRT source (Landi et al. ATEL #1822) coincident with flat-spectrum radio source from SUMMS and AT20G (Sadler ATEL #1843)

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**Our candle is not so standard**

- + Crab flickers in hard X-ray
  - + Fermi GBM reports hard X-ray variability on ~yearly time scales. Confirmed by multiple instruments (C. A. Wilson-Hodge et al. arXiv:1010.2679v1)
- + Crab flares at high energy (>100 MeV)
  - + AGILE reports enhanced Crab flux over a few days, Sept. 19-21 (M. Tavani et al. ATEL #2855)
  - + Fermi LAT confirms flare and triggers LAT ToO (R. Buehler et al. ATEL #2681)
    - + Earlier flare found using new offline all-sky variability search developed by R. Buehler
  - + Fermi LAT reports end of flare. Variability present in off-pulse phase of pulsar (E. Hays et al. ATEL #2893)

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**Two Short Flares from the Nebula**

**Flux of the low energy LAT component**

**Preliminary**

No variability found in pulsar or high energy LAT component

4 week intervals  
*Sun passages excluded*

4 day intervals covering flare periods

arXiv:1011.3855v2 E. Hays

**Crab Flare Spectra**

**Preliminary**

Low energy LAT component shows spectral variability

25 month index:  $3.69 \pm 0.11$

Feb 2009 index:  $4.3 \pm 0.3$


Sept 2010 index:  $2.7 \pm 0.2$


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**Origin of the Gamma-ray Flares?**

- + Gamma-ray luminosity is a small fraction of the pulsar power ( $10^{35}$  erg/s  $\rightarrow \sim 10^{-3} L_{\text{rot}}$ )
- + 4 day duration implies small region size, diameter  $< 1.4 \times 10^2$  pc (1.5 arcsec)
- + Electron synchrotron cooling time in 200 uG  $< \sim 15$  days
- + LAT low energy spectral form + short timescale variability support a synchrotron interpretation
  - + Implies electrons accelerated to >PeV in structures in the inner region near the termination shock and base of the jet

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 **Searching for the Emission Region**



HST/ACS F550M  
2010-10-02  
P. Caraveo et al. ATEL #2903

No corresponding variability found in radio, optical, infrared, soft and hard X-rays at time or shortly after the 2nd LAT flare


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 **Summary**

- ✦ LAT all-sky monitoring is producing spectacular results for the GeV transient sky
- ✦ New blazars and unidentified transients
- ✦ Probing the jet of the Cygnus X-3 microquasar
- ✦ Discovery of gamma rays from V407 Cygni nova
- ✦ Fast high-energy gamma-ray flares from the Crab
- ✦ All-sky monitoring continues. What's next?


<http://fermi.gsfc.nasa.gov>

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 **Extras**

Extras

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 **Other Binary Outbursts in LAT?**

- ✦ No LAT detections of Cygnus X-1
  - ✦ Flux (0.1-3 GeV)  $< 4 \times 10^{-7} \text{ ph cm}^{-2} \text{ s}^{-1}$  during flare reported by AGILE 2009 Oct 16
  - ✦ Nothing found for 2010 March 23-24 period reported by AGILE of during MAXI/GSC soft X-ray brightening June 2010
- ✦ Nothing found yet for black hole candidates GX 339-4, GRS 1915+105
- ✦ Eta Carinae consistent with steady emission (includes 2008 periastron)

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